[0123] **FIG. 27** is a conceptual diagram showing a manufacturing step performed subsequent to the step of **FIG. 26**;

[0124] **FIG. 28** is a conceptual diagram showing a manufacturing step performed subsequent to the step of **FIG. 27**;

[0125] **FIG. 29** is a conceptual diagram showing a manufacturing step performed subsequent to the step of **FIG. 28**;

[0126] **FIG. 30** is a conceptual diagram showing a manufacturing step performed subsequent to the step of **FIG. 29**;

[0127] **FIG. 31** is a diagram showing a measurement method for measuring a sensitive region and insensitive regions of a multilayer film of the magnetoresistive-effect device;

[0128] **FIG. 32** is a graph showing the relationship of the width dimension of an electrode layer formed on a multilayer film, a direct current resistance thereof, and noise generation rate;

[0129] **FIG. 33** is a partial cross-sectional view showing the construction of a conventional magnetoresistive-effect device;

[0130] **FIG. 34** is a partial cross-sectional view showing a magnetoresistive-effect device of the present invention;

[0131] **FIG. 35** is a partial cross-sectional view showing the construction of a magnetoresistive-effect device of a twentieth embodiment of the present invention;

[0132] **FIG. 36** is a partial cross-sectional view showing the construction of a magnetoresistive-effect device of a twenty-first embodiment of the present invention;

[0133] **FIG. 37** is a partial cross-sectional view showing the construction of a magnetoresistive-effect device of a twenty-second embodiment of the present invention;

[0134] **FIG. 38** is a partial cross-sectional view showing the construction of a magnetoresistive-effect device of a twenty-third embodiment of the present invention;

[0135] **FIG. 39** is a partial cross-sectional view showing the construction of a magnetoresistive-effect device of a twenty-fourth embodiment of the present invention;

[0136] **FIG. 40** is a conceptual diagram showing a manufacturing step of the magnetoresistive-effect device of the present invention;

[0137] **FIG. 41** is a conceptual diagram showing a manufacturing step performed subsequent to the step of **FIG. 40**;

[0138] **FIG. 42** is a conceptual diagram showing a manufacturing step performed subsequent to the step of **FIG. 41**;

[0139] **FIG. 43** is a conceptual diagram showing a manufacturing step performed subsequent to the step of **FIG. 42**; and

[0140] **FIG. 44** is a conceptual diagram showing a manufacturing step performed subsequent to the step of **FIG. 43**;

DESCRIPTION OF THE PREFERRED EMBODIMENTS

[0141] **FIG. 1** is a cross-sectional view showing the construction of a magnetoresistive-effect device of a first embodiment of the present invention, viewed from an ABS (air bearing surface) side thereof. **FIG. 1** shows only the central portion of the device sectioned in an XZ plane.

[0142] The magnetoresistive-effect device is a spin-valve type thin-film device, namely, one type of GMR (giant magnetoresistive) devices making use of the giant magnetoresistive effect. The spin-valve type thin-film device is mounted on the trailing end of a floating slider in a hard disk device to detect a magnetic field recorded onto a hard disk. The direction of the movement of a magnetic recording medium such as a hard disk is aligned with the Z direction, and the direction of a leakage magnetic field of the magnetic recording medium is aligned with the Y direction.

[0143] A substrate **10**, fabricated of a nonmagnetic material such as Ta (tantalum), becomes the bottom layer of the device as shown in **FIG. 1**. An antiferromagnetic layer **11**, a pinned magnetic layer **12**, a nonmagnetic electrically conductive layer **13**, and a free magnetic layer **14** are successively laminated onto the substrate **10**. A protective layer **15**, fabricated of Ta (tantalum), is deposited on the free magnetic layer **14**. A multilayer film **16** is thus fabricated of the substrate **10** through the protective layer **15**. Referring to **FIG. 1**, the width dimension of the top surface of the multilayer film **16** is defined as T30.

[0144] The pinned magnetic layer **12** is deposited to be in direct contact with the antiferromagnetic layer **11**, and is subjected to annealing in the presence of a magnetic field. An exchange anisotropic magnetic field takes place through exchange coupling at the interface between the antiferromagnetic layer **11** and the pinned magnetic layer **12**. The magnetization of the pinned magnetic layer **12** is thus pinned in the Y direction.

[0145] In accordance with the present invention, the antiferromagnetic layer **11** is made of a Pt—Mn (platinum-manganese) alloy. The Pt—Mn alloy film outperforms an Fe—Mn alloy film and Ni—Mn alloy film, conventionally used as an antiferromagnetic layer, in terms of corrosion resistance, and has a high blocking temperature, and further provides a large exchange anisotropic magnetic field (Hex). The Pt—Mn alloy film has thus excellent characteristics as an antiferromagnetic material.

[0146] Instead of the Pt—Mn alloy film, the antiferromagnetic layer **11** may be made of an X—Mn alloy where X is a material selected from the group consisting of Pd, Ir, Rh, Ru, and alloys thereof, or a Pt—Mn—X' alloy where X' is a material selected from the group consisting of Pd, Ir, Rh, Ru, Au, Ag, and alloys thereof.

[0147] The pinned magnetic layer **12** and the free magnetic layer **14** are made of an Ni—Fe (nickel-iron) alloy, Co (cobalt), an Fe—Co (iron-cobalt) alloy, or an Fe—Co—Ni alloy, and the nonmagnetic electrically conductive layer **13** is made of a low electrical-resistance nonmagnetic electrically conductive material, such as Cu (copper).

[0148] Referring to **FIG. 1**, hard bias layers **17** and **17** are deposited on both sides of the multilayer film **16**, composed of the substrate **10** through the protective layer **15**. The hard bias layers **17** and **17** are made of a Co—Pt (cobalt-platinum) alloy or a Co—Cr—Pt (cobalt-chromium-platinum) alloy.

[0149] The hard bias layers **17** and **17** are magnetized in the X direction (i.e., the direction of a track width), and the